NLSI Lunar Science Conference

Life Sciences on the Moon

Innovations in LED lighting for Reduced-ESM Crop Production in Space

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2. Orbital Technologies Corporation (ORBITEC)

Why plants?

- Fresh fruits and vegetables
  - Nutrition
  - Potential radiation protection
  - Enjoyment
- Atmospheric regeneration
- Psychological/recreational benefits
- Develop and demonstrate capabilities for Mars and beyond

The Problem

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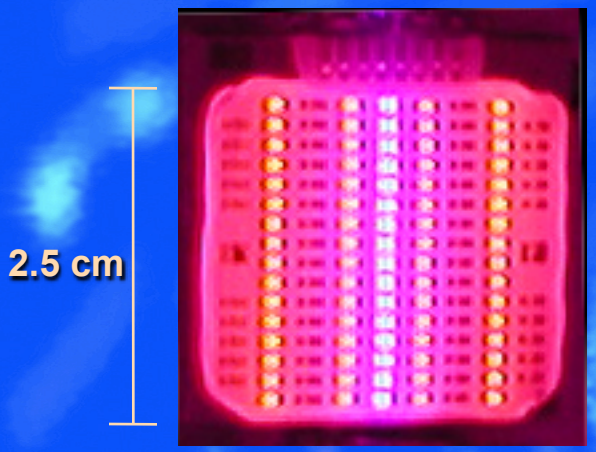
Why LEDs?

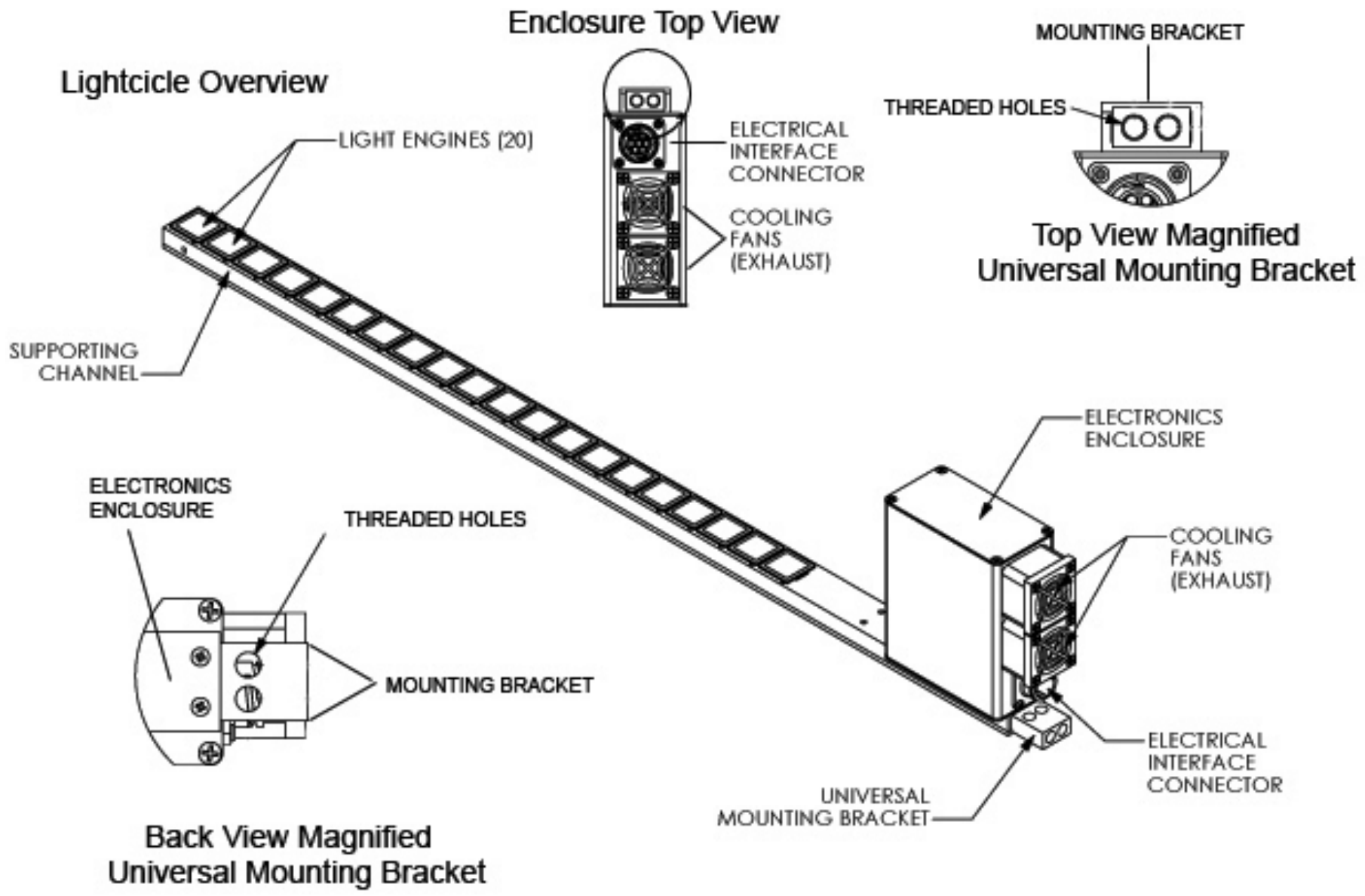
- Small
- Solid state
- Long lifetime ~ 100,000 hr
- Chose wavelengths for plant function
- Can operate at low power
- Emission surface relatively cool
  - Inverse square law $I \propto E / d^2$

Printed-Circuit LED “Light Engines”



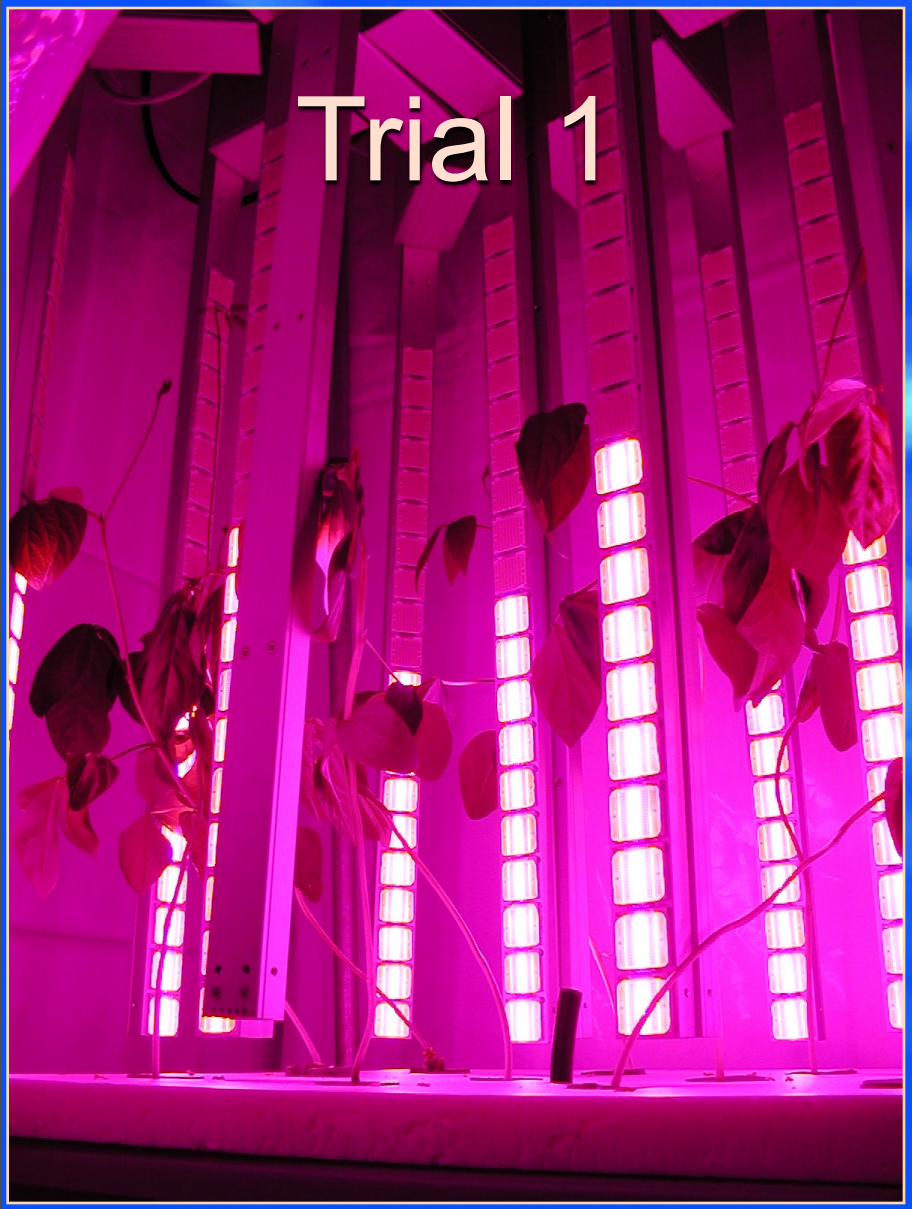
ORBITEC Light Engine

- 1 row of sixteen 440 nm blue
- 4 rows of sixteen 640 nm red
- 2 rows of ten 520 nm green
- 2 photodiodes


Lightcicle Overview
LIGHT ENGINES (20)
SUPPORTING CHANNEL
Enclosure Top View
ELECTRICAL INTERFACE CONNECTOR
COOLING FANS (EXHAUST)
MOUNTING BRACKET
THREADED HOLES
Top View Magnified Universal Mounting Bracket
ELECTRONICS ENCLOSURE
COOLING FANS (EXHAUST)
ELECTRICAL INTERFACE CONNECTOR
UNIVERSAL MOUNTING BRACKET
ELECTRONICS ENCLOSURE
THREADED HOLES
MOUNTING BRACKET
Back View Magnified Universal Mounting Bracket

Trials and Modifications

Trials and Modifications



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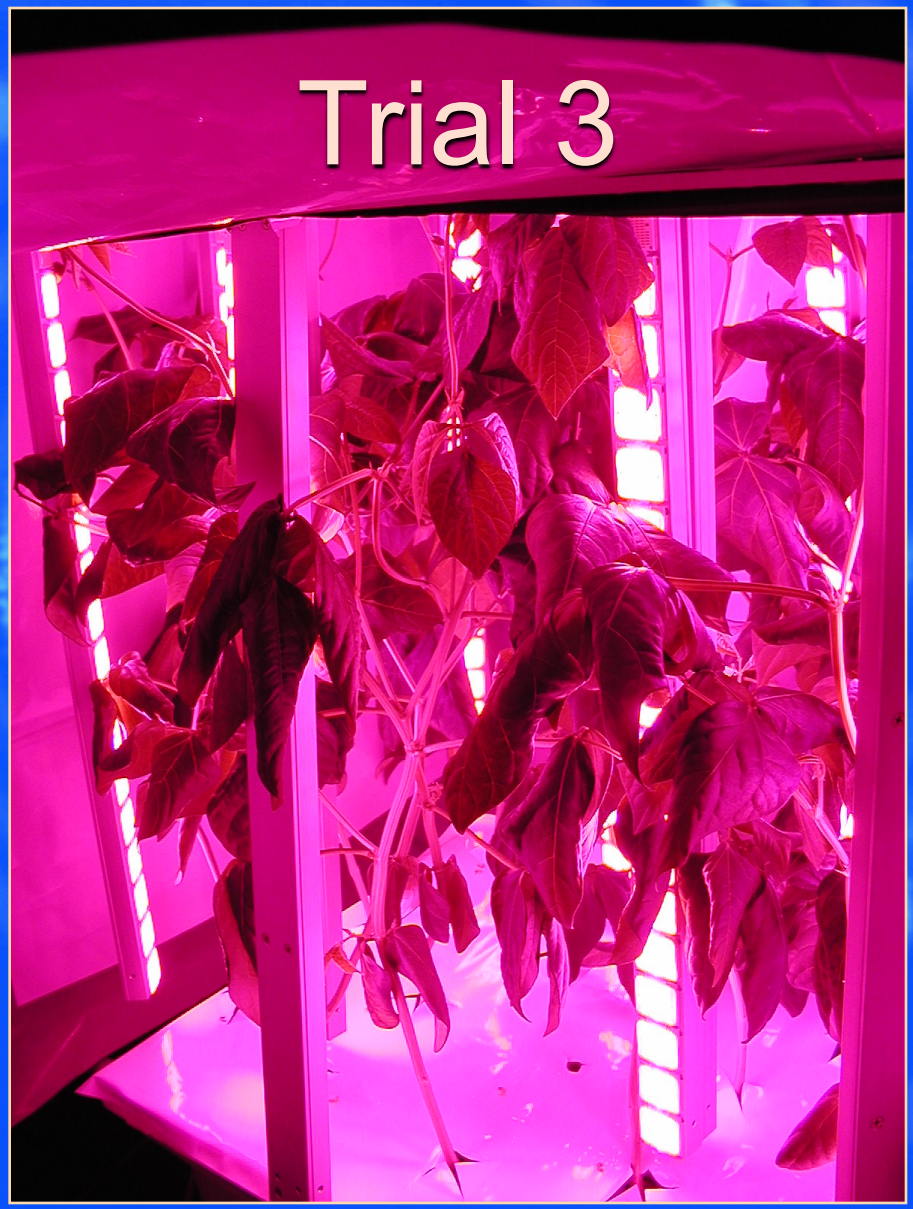

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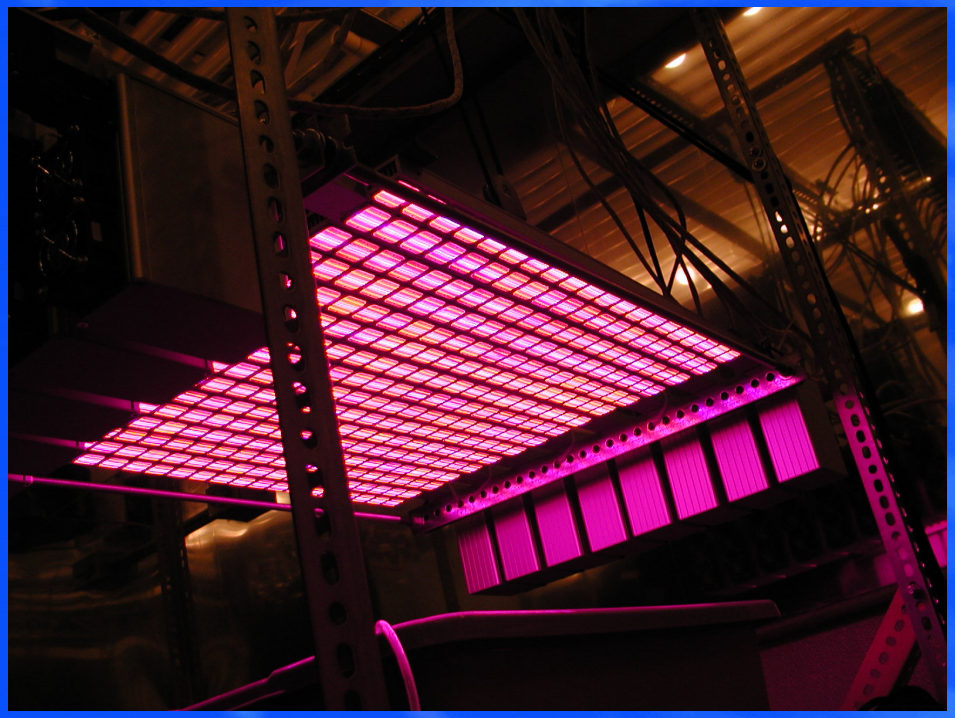
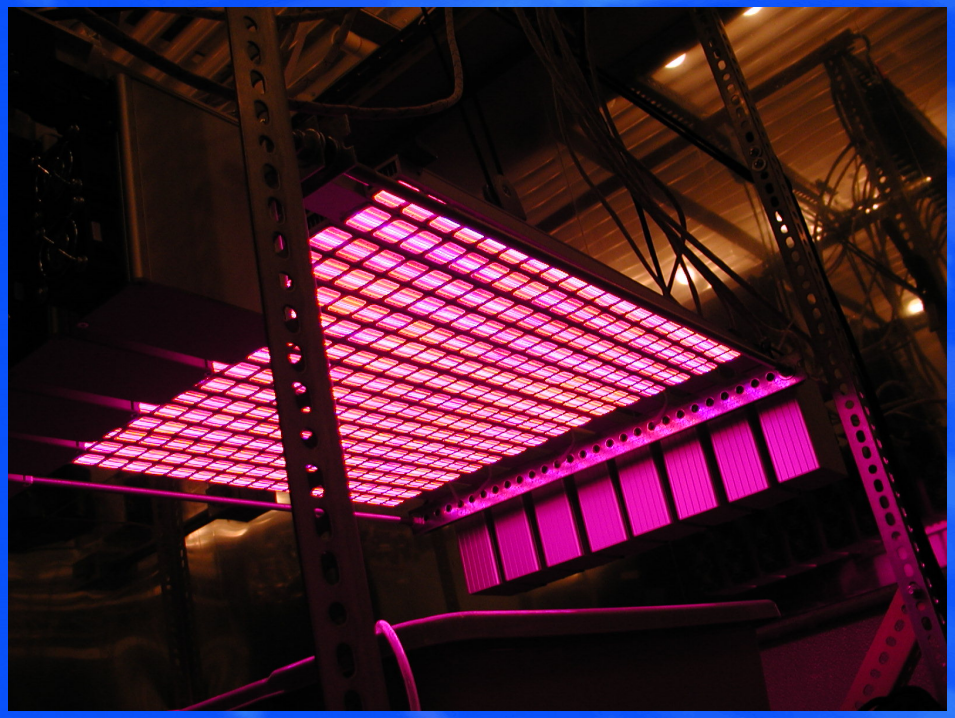
Reconfiguration



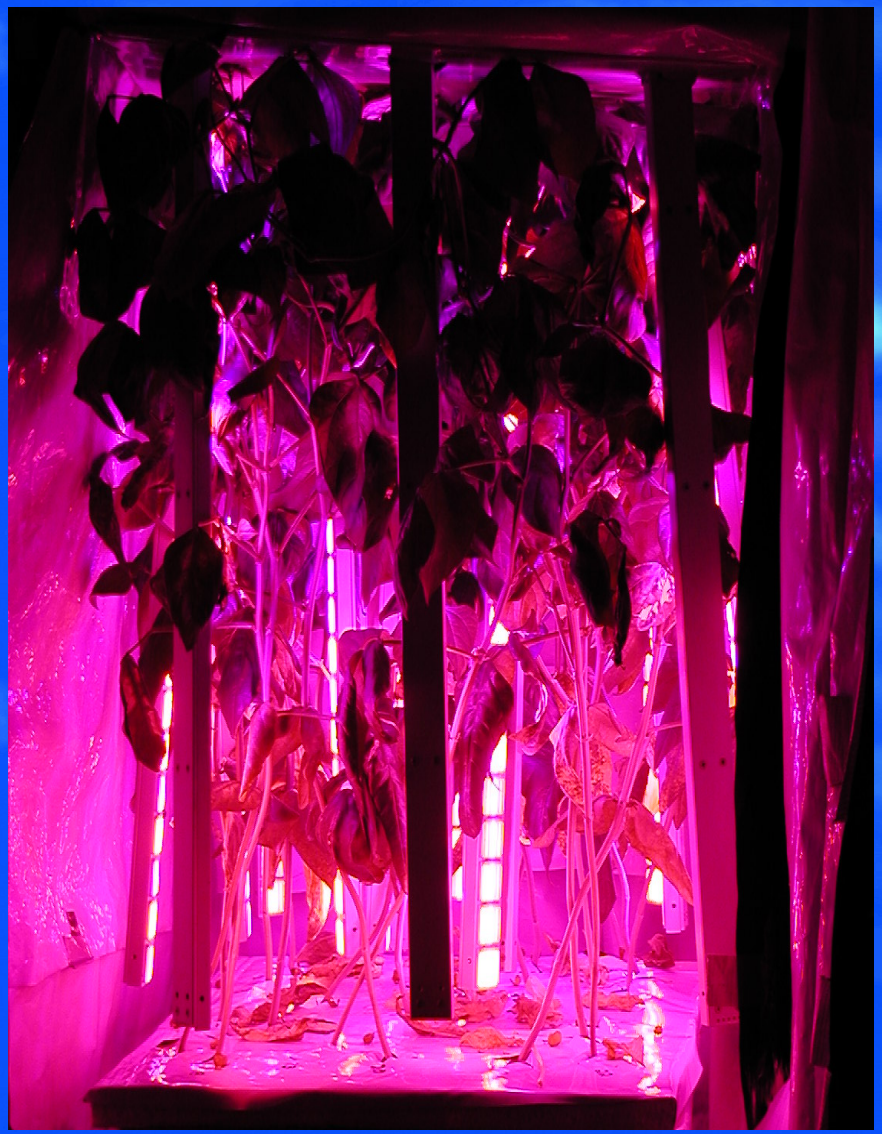
Reconfiguration



Side-by-side Cowpea

IC

OH



Side-by-side Cowpea

IC

OH

HELIAC

High Efficiency Lighting with Integrated Adaptive Control

- Phase I and II NASA SBIR grants awarded to ORBITEC
- Prototype plant position sensor was developed and constructed
- Light from 520 nm G LEDs is flashed/ detected by photodiodes
- R and B LEDs activated where leaves detected.
- Plant testing was performed at Purdue.
- Enables:
  - Automation of height sensing for IC
  - Detection of plant spread for CC array development

Multi-species testing

- Three ALS crop species - Cowpea, Sweetpotato, Tomato
- Arranged to form a canopy
- Repeated as plants grew to get a range of ages

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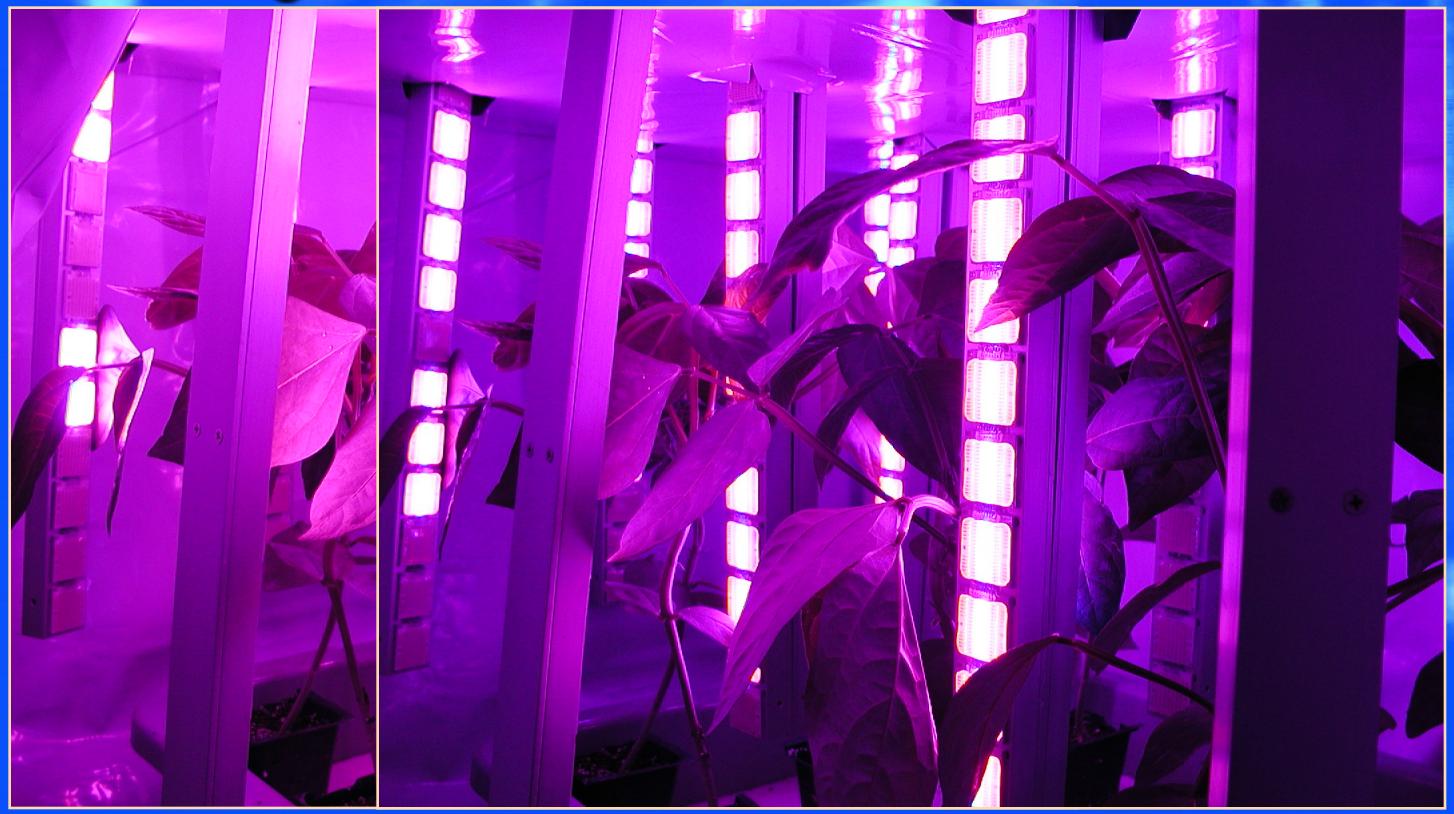

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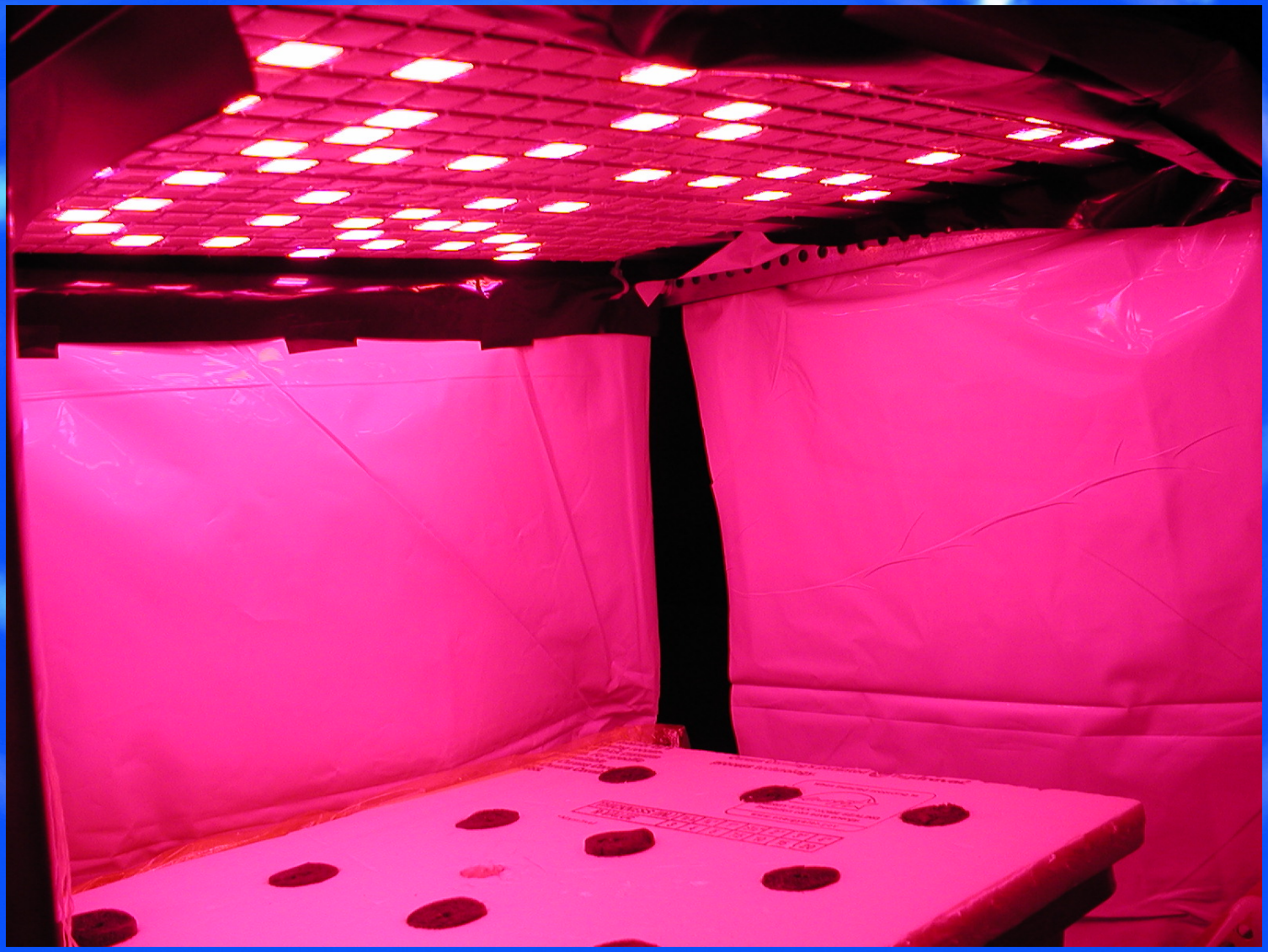
Reconfiguration to Overhead for Close Canopy



HELIAC Lettuce

Future Directions

- Incorporation of lightsicles in custom gas exchange cuvette for real-time photosynthesis measurements
- Further testing and development of HELIAC system including other wavelengths
- Next generation of LED lighting development looking at high-efficiency discrete LEDs vs. engines, alternative arrangements and cooling techniques, crop-specific lighting……

Those who make it happen…

- Mercedes Mick
- Craig Schluttenhofer
- Ashley Hudson
- Elaine Chase
- Dave Kotterman
- Ray Wheeler
- John Sager
- Jonathan Frantz
- Jeff Emmerich
- Tom Crabb